

SOUTH METRO WATER SUPPLY STUDY

Executive Summary

Prepared for:

The South Metro Water Supply Study Board

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Black & Veatch
Rick Giardina & Associates, Inc
HRS Water Consultants, Inc.
Hydrosphere Resource Consultants
Mulhern MRE, Inc.

Purpose of the Study

The purpose of this study was to investigate water supply alternatives for the South Metro area through the year 2050.

Currently, the South Metro area's primary source of water supply is the Denver Basin Aquifers, a large ground water reserve underneath the land within the area's boundaries. The question driving this study is whether this water supply source can adequately meet the long-term demands of the existing population as well as the demands associated with continued population growth.

Additionally, the study investigates whether there are benefits to using surface supplies from the South Platte and Blue River during wet years, along with ground water. This concept, called "conjunctive use," would help preserve ground water supplies by making use of renewable surface water in years when it is plentiful.

Study Participants and Funding

This study was jointly authorized by the Douglas County Water Resources Authority (DCWRA), Denver Water, and the Colorado River Water Conservation District (CRWCD).

The majority of the funding came from the DCWRA participants that include:

- Centennial Water and Sanitation District (Centennial Water)
- Town of Castle Rock (Castle Rock)
- East Cherry Creek Valley Water and Sanitation District (ECCV)
- Arapahoe County Water and Wastewater Authority (ACWWA)
- Cottonwood Water and Sanitation District (Cottonwood)
- Stonegate Metropolitan District (Stonegate)
- Denver Southeast Suburban Water and Sanitation District (Pinery)
- Inverness Water and Sanitation District (Inverness)
- Meridian Metropolitan District (Meridian)
- Roxborough Park Metropolitan District (Roxborough)
- Castle Pines North Metropolitan District (Castle Pines North)

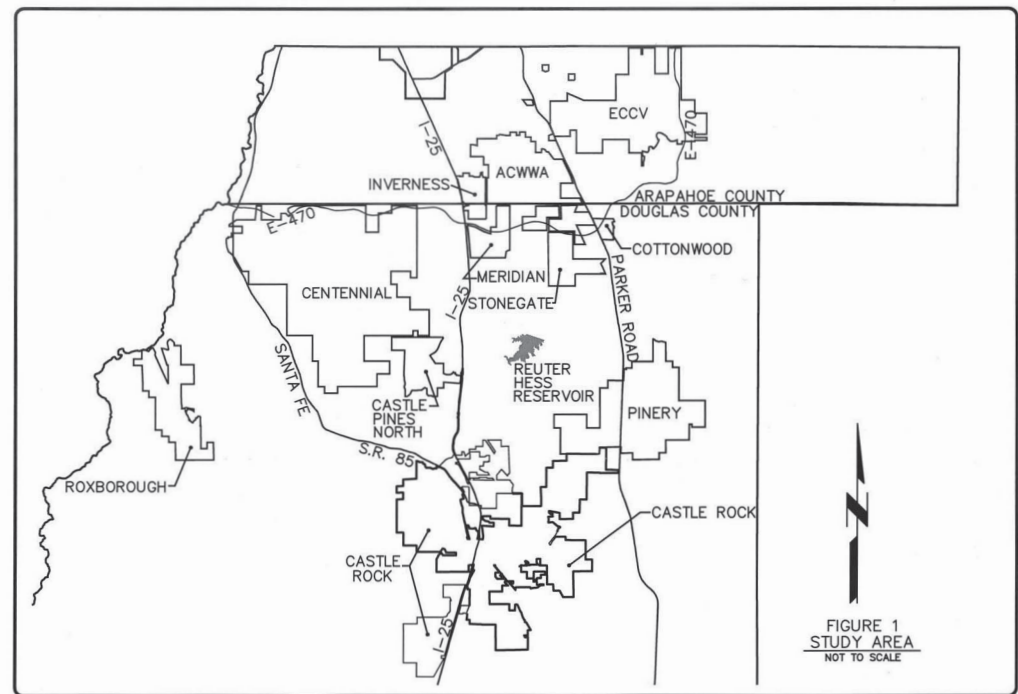
Funding was also provided by Douglas County, the Colorado Water Conservation Board, and the Colorado River Water Conservation District. In-kind services were provided by Denver Water.

Background

The Study Area

The Study Area includes the service areas of the water providers located in the north half of Douglas County. This area includes the Town of Castle Rock north to the Douglas/Arapahoe County boundary, with the exception of most of the Town of Parker. In addition, much of the urbanized portion of Arapahoe County, located east of I-25, is included. The Study Area is shown in Figure 1.

Figure 1



Population

The challenging water situation in the South Metro Study Area is fueled by extremely rapid population growth during the last 25 years and projected rapid growth in the future. During the 1990's, Douglas County had the nation's fastest growth rate. Between 1990 and 2000, population jumped by 191%. Douglas County growth continues at a similar rate today.

In addition, the Arapahoe County portion of the Study Area includes the rapid growth area of the city of Centennial. The growth rate in this portion of Arapahoe County has been similar to that of Douglas County.

The current and estimated population of the Study Area is shown in Table 1. While the study period extends to year 2050, full development occurs by year 2040.

Table 1
Study Area Population
Projections

| Year 2000 | Year 2020 | Year 2040 |
|-----------|-----------|-----------|
| 179,000 | 359,000 | 406,000 |

Water Supply Sources

Water supplies for the Study Area were largely developed during the last 25 years, long after the best sources of surface water from the South Platte River and its tributaries were claimed. While the Study Area has limited surface water from Cherry Creek, Plum Creek and the South Platte River, this water represents only about 25% of the water needed for the area in 2050.

The largest source of available water in the Study Area is deep ground water in the Denver Basin. While this is currently a plentiful source of water, in the future it will be much more difficult and costly to produce at the rates required to serve urban areas. Moreover, the amount of water naturally recharging the deep ground water is very small compared to the water being pumped. Therefore, the volume of water in the aquifer is slowly being depleted. Due to concerns about the long-term viability of the deep ground water, water providers in the South Metro area have taken measures to preserve the deep ground water whenever possible, including pursuing renewable surface water supplies when available.

In general, these water providers have maximized the use of surface water, adopted programs of water conservation, and developed a significant amount of reusable water -- either through augmentation (diverting water in exchange for water returned to the stream) or through non-potable irrigation (water not suitable for drinking). Still, the South Metro area remains heavily reliant upon deep non-tributary ground water (water not connected to the surface stream).

Water Demand

The current and future water demands for the Study Area are shown in Table 2. Full development of the area is expected to occur by 2040. These projections are based upon the historical water use of each of the water providers in the study and include residential and commercial uses and system losses, forming the basis for the analysis in this report.

Table 2
Study Area Water Demand
Projections (Acre-feet)

| Year 2000 | Year 2020 | Year 2040 |
|-----------|-----------|-----------|
| 42,323 | 81,732 | 92,213 |

Alternatives

The alternatives developed for this study are described below.

All of the water providers in the South Metro area currently have water conservation and reuse (recycling of water) programs in place. However, the water providers recognize that more aggressive water conservation and reuse will be needed in the future. Each alternative described below assumes a 15% reduction in outdoor water use, along with expanded reuse wherever practical.

Alternative 1A - Status Quo.

This alternative investigates the possibility of meeting most of the Study Area's future demand by drilling additional wells in the Denver Basin Aquifers and increasing the area's dependence on deep ground water. It identifies the facilities that will be required and examines the costs of producing additional deep ground water supplies. Today, summer peak season demands are met by pumping the deep ground water at high rates. Alternative 1A assumes that peak demands will continue to be met in this manner.

This alternative assumes that water providers will use their existing water rights in the Denver Basin Aquifers. It further assumes that if these water rights are not sufficient to meet demand, more deep ground water will be purchased from nearby locations. Alternative 1A also looks at the infrastructure required to produce and deliver the deep ground water to customers (e.g., wells, treatment facilities and delivery pipelines). In cases where deep ground water would need to be purchased from locations outside the service area, well development and the transmission system required to deliver that water to the water provider's system is identified.

Alternative 1B - Status Quo with Storage for Peaking.

Alternative 1B is identical to Alternative 1A except in the method for meeting peak demands. In Alternative 1B, instead of using wells to meet demands during very high summer peak periods (as in Alternative 1A), deep ground water would be pumped on a year-round basis at a much lower rate. During the winter, when the water pumped would be greater than customer demand, the excess would be pumped to new storage reservoirs. In the summer months, when customer demand exceeds the volume of water pumped, water would be withdrawn from storage to meet demand.

Alternative 1B would require far fewer wells than 1A, but storage reservoirs would be needed. In addition, water stored in open reservoirs would require water treatment before being used in the water system. This alternative considers these changes in infrastructure requirements, as well as the associated costs.

Alternative 2 - Non-Tributary Ground Water with Maximum Reuse.

Alternative 2 is a variation of Alternative 1B that assumes all available water that is legally reusable would be reused to extinction regardless of costs and other issues. In Alternatives 1A and 1B, some of the reusable water supplies in the East Cherry Creek Valley Water and Sanitation District, the Town of Castle Rock, the Meridian Metropolitan District and the Roxborough Park Metropolitan District were assumed not to be fully developed.

While Alternative 2 produces a number of additional water reuse opportunities, institutional constraints -- including existing contracts -- may preclude some of these opportunities from being realized.

Alternative 3A - Conjunctive Use with Borrowing from Denver Water Storage.

Alternatives 1A, 1B, and 2 provide strategies to meet demands for the South Metro area without the import of surface water supplies. The “conjunctive use” alternatives, 3A and 3B, examine whether deep ground water can be effectively used conjunctively with surface supplies from the South Platte and Blue River. Conjunctive use alternatives would preserve ground water supplies by making use of renewable surface water in years that it is plentiful.

Since the conjunctive use alternatives, 3A and 3B, each rely on meeting demand with local water supplies alone in dry years, all of the infrastructure of either Alternative 1A, 1B, or 2 needs to be included as part of Alternatives 3A and 3B, except that the number of additional wells under Alternatives 3A and 3B would be fewer because of lower average ground water pumping.

Alternative 3A is a regional approach to water supply development. Water would be imported from the South Platte River and Blue River in wet years - when surface supplies are plentiful - through Denver Water’s existing raw water system to the west side of the South Metro area. This water would then be delivered to South Metro water providers through a new pipeline distribution system. Alternative 3A would require limited use of Denver Water’s storage capabilities to increase the volume of surface water captured.

In dry years, South Metro water providers would continue to use their existing sources of supply without diverting any water from Denver Water’s raw water system. In wet years, water would be borrowed from Denver Water’s surface water reservoirs prior to runoff (during the late winter and early spring months) for delivery to Douglas County. This would take place at a time when there normally

would not be any water available to a junior water right. The timing and amount of reservoir releases would be based upon two things: 1) Snow pack accumulations during the late winter and early spring; and 2) Denver Water's reservoir levels.

The effect of Alternative 3A would be to lower water levels in the Cheesman and Dillon reservoirs during the late winter and early spring, thereby increasing the potential to capture additional water at these locations during high runoff periods. In years with sufficient above-average runoff, water would continue to be delivered to Douglas County via direct diversions under a junior water right at the same time that Denver's reservoirs would be filling. Assuming Denver Water's reservoirs fill sufficiently, the borrowed water could be used by the South Metro water providers without payback of water to Denver Water.

Because wet years cannot be predicted with certainty, however, there would be years where this water "borrowing" would result in draw-downs to Denver Water's reservoirs that would not refill from late spring runoff. In these cases, the borrowed water would have to be paid back to Denver Water. While the water would need to be paid back in the same year, the payback could potentially be delayed until the fall and winter. Payback water would be the same water that was "borrowed" and stored in new South Metro storage reservoirs.

Denver Water's surface water model, PACSM, was used to simulate the delivery of surface water to Douglas County in Alternative 3A. In this model, the water rights used for Douglas County's benefit were assumed junior to those of Denver Water and other major metropolitan water supply systems (e.g. Aurora, Thornton, Englewood, etc.), as well as those of Grand and Summit Counties. This means that this new water right would not impact any other entities' water rights on these rivers.

Alternative 3A assumes 39,000 acre-feet of new reservoir storage would be developed in the South Metro Area to store water borrowed from Denver Water. Also, new raw water pipelines, pumping stations and water treatment facilities would be constructed so that treated water could be distributed to the individual water providers' systems.

Alternative 3B - Conjunctive Use with Free River Water.

Alternative 3B is very similar to Alternative 3A except that water from the upper South Platte and Blue River is diverted directly without using existing Denver Water storage facilities.

Under this "free river only" scenario, water would be diverted from the South Platte and/or Blue River and would be transported to the South Metro area in the same manner as in Alternative 3A. Normally water would only be available for diversion during periods of relatively high river flows, typically in May and June.

Under Alternative 3B, diverted water could be used to directly meet the water demands of Douglas County providers, stored in surface reservoirs, or used to recharge the Denver Basin Aquifers. In general, the infrastructure required in Alternative 3B is the same as Alternative 3A.

STUDY METHODOLOGY

A major component of this study was to develop a “water management model” to determine which sources of water supply would be used to meet the individual water provider’s demands. The results of this analysis identified the volume of water needed from each source for each alternative during the study period. Particularly important in this analysis was the determination of how much deep ground water pumping was required.

The next step was to model and evaluate the use of the Denver Basin ground water, both in terms of available volume and production. This included the development of a Regional Ground Water Model to estimate the water levels in the aquifers with varying rates of production under each alternative. The model was developed using MODFLOW 2000, with the SB-74 model developed through the State Engineer’s Office as its base. The results of the analysis estimate the projected water levels in the four Denver Basin Aquifers over the study period, which extends to 2050.

This information was then used in the “Local Well Analysis” to calculate the maximum production capacity of a well during the study period. The “Local Well Analysis” also considers the well-to-well interference caused by multiple wells pumping in the same area. The analysis identified the maximum pumping rates of wells at different locations, and the number of wells required to meet the need for ground water.

Next, infrastructure requirements were determined for each of the alternatives, including wells, storage facilities, water treatment facilities, distribution pipelines, pumping facilities, and any other infrastructure necessary to implement each alternative. The infrastructure requirements were then put into a “Cost Estimating Model” that determined capital, operation and maintenance, and repair and rehabilitation costs for each water provider in each alternative during the study period.

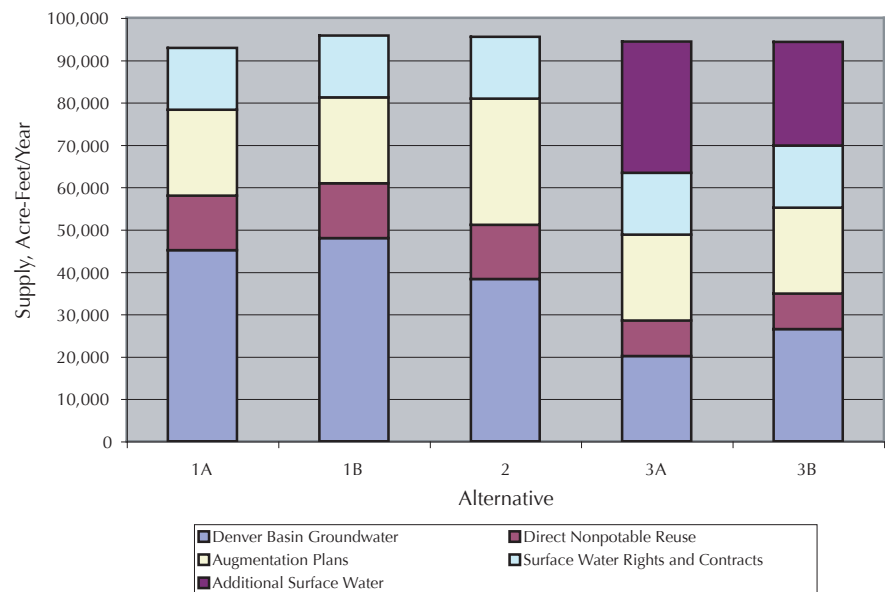
The total cost estimates for each alternative were then used in a “Financial Model” that provided a comparison of alternatives based upon the calculated tap and service fees. The “Financial Model” assumed that capital costs to meet demands from this time forward would be paid through tap fees and that facilities associated with existing demands would be paid through service fees. The “Financial Model” also compared alternatives based upon the present value of revenues required for each alternative.

KEY FINDINGS

Water Supply Comparisons for 2050

The water management model was run for each alternative. The model created a water supply management plan for the individual water providers and for the study area as a whole. The results of the modeling for the area as a whole in 2050 are presented for each alternative in Figure 2 below. These results show the volume of water to be used from each available water supply source. Of particular interest is the volume of ground water pumping required.

Figure 2
Comparison of 2050 Results



The chart above illustrates that the annual volume of ground water pumped is highest in Alternatives 1A and 1B and decreases substantially in Alternatives 2, 3A and 3B. In Alternative 2, the reduction in ground water use is due to increased reuse of approximately 9,400 acre-feet. This is the maximum amount of reuse that can be achieved. Realistically, it will be less than this projection.

In Alternative 3A, the reduced ground water pumping is due to gross water deliveries from the South Platte and Blue River that would average about 36,000 acre-feet per year, with payback to Denver Water averaging about 10,000 acre-feet per year. Thus, this “free river with borrowing” scenario would produce an average net yield (deliveries minus payback) of approximately 26,000 acre-feet per year. Of this amount, approximately 15,000 acre-feet per year would come from the Blue River and approximately 11,000 acre-feet per year would come from the South Platte River. However, there would be extended dry periods (four years or longer) when there would be little or no surface water available from the South Platte or Blue River under this scenario.

In comparison, Alternative 3B, the free river only scenario, would reduce ground water pumping by producing an average net yield of approximately 19,000 acre-feet per year from the South Platte and Blue River, with about half coming from each. There would be no payback to Denver Water in this scenario.

These results show that ground water pumping can be greatly reduced under Alternatives 2, 3A, and 3B. However, the reduced levels of ground water pumping under Alternative 2 are probably unrealistic due to overly optimistic maximum reuse projections.

Aquifer Water Levels and Pumping Rates Over the Study Period

An important goal in evaluating the Denver Basin Aquifers as a source of water supply for the South Metro area was to understand the viability of the supply on a long term basis. The study found that the key issue today is not the draining of the resource, but instead exceeding the reasonable and prudent production capability of the aquifer system.

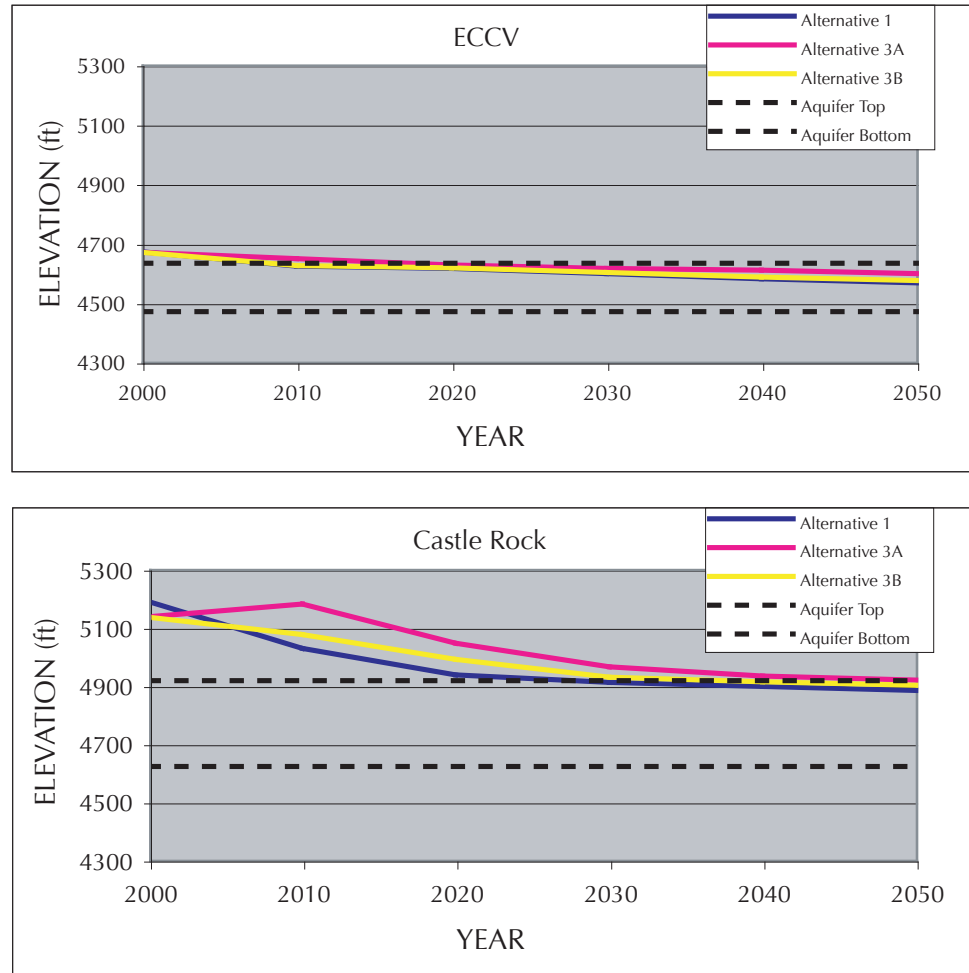
The study shows that in urbanized areas, even though the volume of appropriated water may be sufficient to meet demands, the water supply cannot be produced at the appropriated volume without large drawdowns in the aquifer water levels. In the future, these large drawdowns will reduce well production drastically and make production difficult and costly.

Even with expanded conservation and reuse by water providers, the study found that the projected pumping volume will dissipate the artesian pressure from the Denver Basin Aquifers to a large extent over the next 10 to 20 years. This artesian pressure has greatly aided well production in the past since the ability to pump water is directly proportional to pressure. While the water associated with the artesian pressure is a small percentage of the total water volume in the aquifer, the loss in artesian pressure represents a large percentage of the pressure available to obtain water from the aquifers. As such, the problem with continued pumping of the Denver Basin Aquifers is much more related to a significant drop in the rate of well production (the gallons per minute of withdrawal) as opposed to the diminishment of total water stored in the aquifers.

The graphs in Figure 3 show, as examples, the decline in water levels in the Arapahoe aquifer at two locations over the course of the study period.

In some of the areas, there is little dewatering of the aquifer while in other areas, there is significant dewatering. In all cases, the artesian pressure, which benefits well productivity, is either lost or reduced to a minimum in the next 10 to 20 years. Similar results apply to all South Metro area water providers.

Figure 3
Arapahoe Aquifer Regional
Ground Water Levels



The results of the local well analysis also indicate that the lowering of regional ground water levels is severely compounded by the well-to-well interference that will occur if these aquifers are pumped at the projected rates. The analysis found well-to-well interference can further lower pumping water levels by more than 100 feet.

As regional water levels drop to near the top of the aquifer, the additional drop in ground water levels caused by well-to-well interference will result in a dramatic loss in well production. In 2003, the maximum Arapahoe aquifer pumping rates in the

South Metro Area generally ranged from 500 to 600 gpm. The study found that in Alternative 1A the pumping rate will drop in a typical well to 300 gpm by 2010, and to 80 gpm by 2050. The resulting loss in production is somewhat less for other aquifers, however, other aquifers start with much lower production rates than the Arapahoe Aquifer. These results are shown for each alternative in Figure 4.

Of particular significance is that by the year 2050, a well producing a maximum of 100 gpm in any aquifer will be considered successful in terms of production. But wells producing only 100 gpm are extremely uneconomical and the cost for the number of wells required to meet demand in that scenario will be considerable.

Figure 4
Average Maximum Pumping
Rate by Aquifer, Alternative 1A

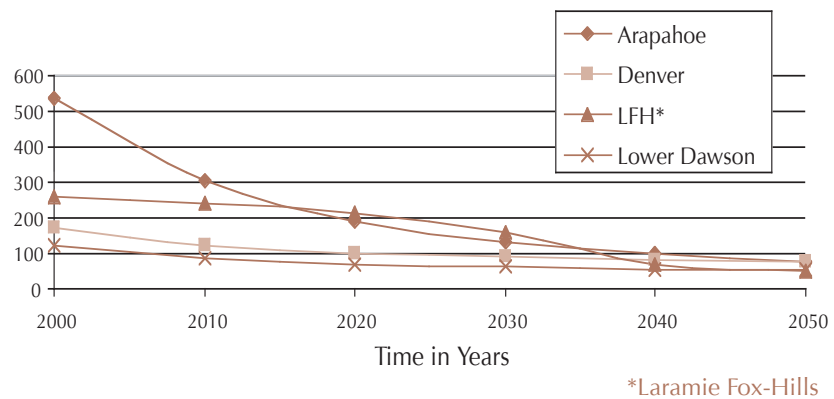


Table 3 shows the total number of additional wells required by alternative and aquifer to meet demands by 2050. Well construction and infrastructure is very costly and these wells represent huge increases in required capital facilities costs.

Table 3
Total Number of Additional
Wells By Alternative & Aquifer

| Alternative 1A | 57 | 210 | 954 | 143 | 1364 |
|----------------|----|-----|-----|-----|------|
| Alternative 1B | 32 | 180 | 373 | 75 | 660 |
| Alternative 2 | 28 | 173 | 115 | 65 | 381 |
| Alternative 3A | 30 | 38 | 146 | 84 | 298 |
| Alternative 3B | 30 | 69 | 140 | 78 | 317 |

Infrastructure Requirements and Associated Costs for Each Alternative

The water management model and the results of the ground water analyses were used to determine the infrastructure required for each alternative. The infrastructure costs were input into the costing model, and the total costs of each alternative are summarized in Table 4 below.

*Table 4
Total Estimated Project
Costs By Alternative*

| GRAND TOTAL FOR ALL PROVIDERS | Initial Capital Construction Cost | Annual O&M Costs | Periodic Repair & Rehab Costs | Present Value of Total Costs |
|-------------------------------------|---|---------------------|----------------------------------|---------------------------------|
| Alternative 1A | \$2,310,078,000 | \$40,844,000 | see detail report | \$4,036,076,000 |
| Alternative 1B | \$1,396,506,000 | \$33,551,000 | see detail report | \$2,700,834,000 |
| Alternative 2 | \$1,090,991,000 | \$31,535,000 | see detail report | \$2,251,857,000 |
| Alternative 3A | \$1,654,971,000 | \$35,145,000 | see detail report | \$2,998,845,000 |
| Alternative 3B | \$1,422,202,000 | \$29,643,000 | see detail report | \$2,551,220,000 |

Table 4 shows total project costs between \$2.2 and \$4.0 billion. These are estimates of the total capital, operation and maintenance, and repair and rehabilitation costs over a 45-year period for 11 different water providers. To better understand what these costs mean, the study looked at the project revenue requirements over the 45-year period.

Alternative 2 as an Enhancement

The purpose of studying Alternative 2 was to examine opportunities to develop more water reuse as a way to meet the area's water needs and preserve ground water. The study found that while there are a number of possible reuse opportunities, some of them are most likely not achievable due to existing agreements, plans and other jurisdictional and institutional constraints. Therefore, this option is not a stand alone alternative, but instead an enhancement of the other alternatives.

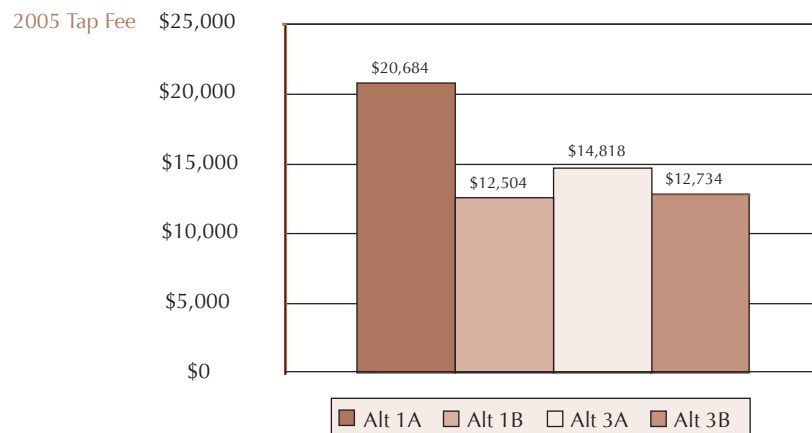
As a result, Alternative 2 is not reflected in the revenue requirement summary below which addresses tap fee and service fee projections.

To the extent that some of these reuse opportunities are developed, they would reduce the overall cost of Alternatives 1B, 3A and 3B, and further reduce long-term ground water pumping. This would reduce tap and service fees for those alternatives.

Revenue Requirements for Each Alternative

The cost projections were used to develop the estimated revenues from tap fees and service charges that would be needed to fund each alternative. For financial modeling purposes, tap fees are assumed to be effective in 2005 and the revenues generated are used to fund the share of annual construction costs attributed to new growth, or are retained for payment of debt service if these construction costs are less than the amount of tap fee revenue available. Figure 5 illustrates the average additional 2005 tap fees for each alternative which would vary for each water provider. The additional tap fees would generally be added to existing tap fees. Some costs, however, would be duplicative and the total tap fees would need to be determined by each water provider independently.

Figure 5
2005 Additional Tap Fees
By Alternative



Alternative 1B is assumed to be the least-cost ground water development alternative in this study. Alternative 1B was used as the basis for the “conjunctive use” alternatives, Alternatives 3A and 3B.

Service charges were calculated annually to recover operation and maintenance costs, and repair and rehabilitation costs, and to meet the proportion of construction costs and debt service not covered by tap fees. Table 5 shows the annual service charge increase as a present day cost, without inflation for each alternative.

Table 5
Additional Future Service
Charges Without Inflation
(\$ per 1,000 gallons)

| Year | Alternative 1A | Alternative 1B | Alternative 3A | Alternative 3B |
|------|----------------|----------------|----------------|----------------|
| 2010 | \$0.43 | \$0.81 | \$1.81 | \$1.03 |
| 2030 | \$1.15 | \$1.36 | \$1.40 | \$0.89 |
| 2050 | \$2.94 | \$1.83 | \$1.73 | \$1.59 |

Actual tap and service fees will vary for each water provider depending upon the level of existing development, existing tap and service fees, their required infrastructure, and financial policies of the entity. A water provider may choose to bear more of the financial burden through service fees, and to the extent service fees are increased, tap fees would be reduced to maintain the required revenue.

Financial Analysis

A summary of the costs, tap fees and service fees for each alternative is presented in Table 6.

*Table 6
Costs and Incremental Fees
Summary By Alternatives
(Present Day Costs)*

| Alternative | Capital Cost (billions) | Total Cost (billions) | Incremental Tap Fee | Incremental Service Fee* |
|-------------|----------------------------|--------------------------|------------------------|-----------------------------|
| 1A | \$2.31 | \$4.04 | \$20,684 | \$2.94 |
| 1B | \$1.40 | \$2.70 | \$12,504 | \$1.83 |
| 3A | \$1.66 | \$3.00 | \$14,818 | \$1.73 |
| 3B | \$1.67 | \$2.55 | \$12,734 | \$1.59 |

*Incremental Service Fee estimated in 2050 without inflation

Alternative 1B shows that water providers can reduce capital and operating costs very substantially relative to Alternative 1A, the status quo alternative, by reducing the maximum rate of well production (the gallons per minute of pumping) by pumping at a constant rate year round. The reduced costs in Alternative 1B primarily reflect the fact that water providers need less than half the number of wells required in Alternative 1A (660 wells versus 1364, see Table 3). However, in order to meet peak demands in Alternative 1B, water providers must build storage and treatment facilities, the estimated costs of which are included.

In Alternative 1B, capital costs, total costs, tap fees and service fees are all significantly less than those in Alternative 1A. While this still represents significant tap and service fee increases, this is significantly better than revenue requirements for the status quo alternative (1A).

Alternatives 3A and 3B, the “conjunctive use” plans, would greatly reduce the reliance of the South Metro area on ground water. The capital costs of Alternative 3B are only slightly in excess of those in Alternative 1B, and the total cost actually makes it a less expensive option than Alternative 1B. Alternative 3A, meanwhile is 300 million dollars more expensive the Alternative 1B when considering all costs.

Alternative 3A provides 37 percent more water from the South Platte and Blue River than 3B, but, the additional water comes at considerable cost. Furthermore, a key advantage of Alternative 3B is that it does not impact Denver Water's storage under a borrowing scenario.

Conclusions

The findings of this study indicate that continued reliance on the deep ground water aquifers to meet urban demands in the South Metro Area will result in very large increases in capital and production costs in the foreseeable future, and perhaps the eventual loss of ground water as an economically viable resource.

The study highlights the fact that expected declines in artesian pressure and ground water levels will seriously impact the provider's ability to efficiently produce deep ground water supplies. In every alternative, the artesian pressure will be depleted or reduced to a minimum over the next 20 years, thereby requiring ever-increasing numbers of additional wells to produce the same volume of water. The results of the infrastructure costing analysis show that ground water pumping to meet future demand will be extremely costly. Therefore, any effort to reduce ground water pumping will result in significant cost savings.

The bottom line: From a water management perspective, this study indicates that the South Metro Denver region could drastically reduce its future level of reliance on Denver Basin ground water by vigorously pursuing a combination of water conservation, augmentation and reuse, surface water development, storage, and aquifer recharge initiatives.

Alternative 1A (Status Quo) – This alternative, which relies most on increased ground water pumping, becomes increasingly expensive in the foreseeable future and may be economically unsustainable in the long-term.

Alternative 1B (Status Quo with Storage for Peaking) – This alternative reveals that reducing the number of wells saves significantly more than the cost increase associated with the construction of water storage and treatment.

Alternative 2 (Non-Tributary Ground Water with Maximum Reuse) – The reuse strategies in Alternative 2 should be fully pursued since, in all cases, the cost of developing reuse is less expensive than further development of ground water. To the extent this reuse can be achieved, this alternative becomes an enhancement to Alternatives 1B, 3A and 3B.

Alternative 3A (Conjunctive Use with Borrowing from Denver Water Storage) – This alternative results in surface water import of an average of 26,000 acre-feet per year during the study period, which amounts to about 1.1 million acre-feet less ground water usage than Alternative 1B over the study period.

Alternative 3A is estimated to cost about \$300 million more than Alternative 1B including capital, operation and maintenance, and repair/rehabilitation costs.

Alternative 3B (Conjunctive Use with Free River Water) – This alternative is actually less expensive than Alternative 1B when considering all costs. It creates less new surface water yield than 3A, averaging 19,000 acre-feet per year, but the 19,000 acre-feet is gained with about the same capital cost and less total cost than any of the groundwater alternatives. This is because the savings achieved through reduced well pumping almost equals the cost of the infrastructure necessary to import renewable water and operating costs are considerably less. This plan also avoids the need for a payback scenario to Denver Water and avoids environmental concerns associated with reduced water levels in Dillon and Cheesman Reservoirs.

3A and 3B Additional Cost Considerations – It is important to note two significant considerations in reviewing costs for Alternatives 3A and 3B:

First, Alternative 3A assumes the use of Denver's raw water storage and treatment facilities, and both Alternatives 3A and 3B assume the use of Denver Water's delivery systems to capture and convey flows to the South Metro area. Denver Water has not yet agreed to allow the use of these facilities. If Denver Water were to cooperate in such a plan, they would need to be compensated appropriately for the use of these facilities. While estimated compensation costs to Denver Water are included in these alternatives, at this point the exact compensation and the means of compensation have yet to be determined.

Second, Alternatives 3A and 3B assume additional surface water depletions from the Blue River and the South Platte River. Additional depletions will need to be mitigated, and the cost of mitigation is expected to be substantial.

Therefore, the costs for Alternatives 3A and 3B are not complete, and are likely to be significantly higher than presented herein.

The conjunctive use alternatives present a prudent approach to water development. These plans include expanded conservation, high percentages of reuse, and a component of ground water production. The plans conjunctively use surface water and ground water to create a better balance of water supplies -- relying more on surface water in wet years and more on ground water in dry years.

Recommendations

Implement the measures aimed at reducing the volume and the rate of ground water withdrawals, including expanded conservation, maximum reuse, and the import of renewable surface water through a conjunctive use plan. This study indicates the cost of water conservation and water reuse in almost any form is economically beneficial to the South Metro water providers, individually and collectively.

Seek further information from Denver Water and the Colorado River Water Conservation District related to Alternative 3B. The eventual costs of Alternative 3B would include actual charges Denver Water might impose for use of its facilities, mitigation for West Slope impacts and other costs. These costs will need to be added to the currently identified costs for Alternative 3B, before this alternative can be truly compared to the 1B groundwater alternative. However, by 2050, Alternative 3B would reduce the draw on the aquifer system by an estimated 1 million acre-feet and provide an average of 19,000 acre-feet annually of renewable water yield to the South Metro Area. In addition, reuse opportunities could almost double the actual value of supply realized through the importation of this water. Further analysis of this alternative should seek to increase this yield since it would be fairly small for a project of this magnitude.

The other significant benefit of Alternative 3B is that the project could be phased in and partially implemented with minimal initial infrastructure. The water storage and delivery systems of Denver Water are already in place and deliveries of excess water in wet years could be made to a number of participating water providers. Centennial and Inverness already have connections to Denver Water that would allow for delivery of some water under this plan. In addition, with a very short pipeline connection, Denver Water could connect with East Cherry Creek Valley's existing pipeline along C-470 near Quebec Street, enabling water deliveries to ECCV, Meridian, Stonegate and Cottonwood through this pipeline.

However, before this phasing could occur, Denver Water and the Colorado River Water Conservation District have defined a need for a single entity from the South Metro Area to negotiate and implement a potential project. In addition, Denver Water has given no indication that it is amenable to phased implementation.

Alternative 3A should not be entirely eliminated from further consideration at this point. Instead, this plan should continue to be considered as further information is developed with Denver Water and the Colorado River Water Conservation District as part of these potential conjunctive use plans. Alternative 3A provides an additional 7,000 acre-feet of average annual water delivery beyond the 19,000 acre-feet of Alternative 3B. This additional yield would be very important to the South Metro Area.

Additional reuse strategies contained in Alternative 2 should be fully pursued and implemented where these additional reuse opportunities are deemed achievable. This additional reuse would reduce the total cost of water supply and further maintain the viability of the ground water through an additional reduction in ground water withdrawals.

The decision to pursue a course of action must be made by the water providers as a unified group. The Boards of Directors of each District and the Town Council of Castle Rock will need to decide if they are willing to pursue a conjunctive use plan. These decision-makers also will need to consider a large near-term increase in tap and service fees necessary to fund any of these alternatives.

If the water providers as a group decide to pursue Alternative 3A or 3B, then discussions can be initiated with Denver Water to determine costs, appropriate compensation and other requirements regarding this alternative. At the same time, deliberations could begin with the Colorado River Water Conservation District regarding a study that would identify the impact of stream depletions and consider various mitigation plans that would properly compensate the area for additional surface water diversions.